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Northern and Native-Grown Potato Seed Stock

BY K. C. WESTOVER

AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE, WEST VIRGINIA UNIVERSITY
F. D. FROMME, Director
MORGANTOWN

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*In cooperation with the U. S. Department of Agriculture, Washington, D. C.
†In charge of the Lakin Experiment Farm, Lakin, W. Va.
**In cooperation with the State Department of Agriculture, Charleston, W. Va.
‡In charge of the Reymann Memorial Farms, Wardensville, W. Va.

Northern and Native-Grown Potato Seed Stock

by K. C. WESTOVER

THE POTATO is one of the most valuable cash crops grown in West Virginia. In the last fifteen years much progress has been made both in the culture and the marketing of the crop until now its production is considered one of the highly specialized industries of the state. The entire commercial crop is consumed as food, and no attention is given to the production of seed stock. The raising of early market potatoes is confined principally to the Ohio and Kanawha River valleys, while the late crop is, for the most part, produced in the upland sections (Preston, Randolph, Tucker, Hampshire, and Pendleton counties). Potato yields at present compare favorably with those of the well-established main-crop producing sections of the North. In view of the fact that several growers at different altitudes have had little difficulty in maintaining high-yielding seedstocks by hill selection, there has naturally arisen a question as to the practicability of producing potato seedstocks in West Virginia under the assumption that the favorable growing conditions attributed to the more northern latitudes might, in this respect, be paralleled by those in the higher altitudes of West Virginia. A brief résumé of the literature pertinent to the question may, at this point, be of interest.

SURVEY OF LITERATURE

Stuart *(8)* while at Vermont used European varieties obtained from Scotch and English seedsmen in a series of tests in progress from 1905 to 1910, to determine the "extent and persistency of place-effect on environmental influences on the potato through successive generations." He found from his observations of eight varieties for six seasons, of three varieties for five seasons, of one variety for three seasons, and of one variety for two seasons, that invariably the Scotch seed outyielded seed produced in England. He concluded that northern-grown seed was superior to that grown farther south; in fact, that one year's removal from the North caused noticeable deterioration, which became more rapid in the succeeding years. Several years in the North were required to regenerate the stocks to their original vigor.

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In this respect a topographical study of England and Scotland reveals that there is only a small area, extending from the central to the north-central part of England, in which the altitude exceeds 2000 feet. England is, for the most part, a relatively low, rolling countryside. On the other hand, the greater part of the area of Scotland is from 2000 to 4000 feet above sea level. Very little is low-lying or level. Thus it is possible that Stuart's findings in these experiments may have been due to altitude as well as latitude, or perhaps a combination of the effects of both. This author also cites the work of Minott, who, when at the Vermont Station, collaborated with the Maryland Station during 1888 and 1889 in making comparative tests at each station of several varieties which had previously been grown in the same locality. The northern-grown seed outyielded the Maryland-grown stock by 53 percent.

Wessels and Hartwell *(9)*, reviewing early experiments conducted at the Rhode Island Station, which dealt with the relative value of northern and southern-grown stocks, state that the average loss from the use of the southern-grown stock was 66 bushels per acre, some 123 comparisons having been made during the course of the experiments. This decrease resulted in spite of attempts in many cases to maintain yields of tuber-unit selection. Schultz and Folsom *(6)* in 1925 found that the farther south potatoes were grown, the greater was the percentage of disease. Martin *et al (5)* in 1925 reported experiments conducted for three years, in which the same strains of Maine vs. southern New Jersey fall-crop seed and their progenies were compared each year in both states. Green Mountain and Irish Cobbler varieties were used. Cobblers from New Jersey were a few days slower in germinating and even longer in maturing, but no difference was noted with the Green Mountain variety. In general the New Jersey seedstocks were smaller and less mature. Maine seed produced more stems per plant, but this was offset by a greater percentage of disease. The yields were not significantly different.

In 1922 Bevan *(1)* wrote that the growers on the Plains of Cyprus, on the Isle of Cyprus in the Mediterranean, prefer seed potatoes which have grown a year in the cool climate high in the mountains. This is supposed to renew or prolong the vigor of the stock. Williams and Mathews *(10)*, as a result of trials run for six years in eastern Carolina, state that certified mountain-grown Cobblers from the North Carolina mountain sections are equal to Main certified Cobblers in both earliness and yield. Smith *(7)* in trials on the eastern shore of Virginia compared Virginia mountain-grown Irish Cobblers and Green Mountain seed potatoes with those of the same varieties from Maine and Prince Edward Island, and found the Virginia seed to yield more, to contain less disease, and to show a decidedly more healthy appearance in the field. The Prince Edward Island stocks were next best.

Jehle and Oswald *(2)* have recently reported tests in which they compared seedstocks from northern and western sources, from the mountains of western Maryland and Virginia, as well as New Jersey fall-grown and home-grown seed stocks. Plantings were made in Washington County, Maryland. The largest yields were from northern-grown certified seed, with mountain-grown certified seed second and fall-grown certified seed third. These results indicate that healthy and vigorous stocks are most likely to be obtained in the North or in the higher altitudes of sections farther south.

This brief review of the literature would indicate that there is a reasonable possibility of raising good seed-potato stocks in the higher altitudes of West Virginia.

OBJECTS

The experiments reported herein, in progress from 1921 to 1924, inclusive, were planned with a two-fold object:

(1) The determination of the relative yields of a recommended northern Smooth Rural potato seedstock and the native strains of the same variety from a high and a medium altitude, when all are grown together at several altitudes in the state and in two latitudes out of the state; and

(2) The observation of possible similarity of effect of change of latitude as contrasted with change in altitude in West Virginia.

MATERIALS AND METHODS

The northern-grown seed used in these trials was produced by O. J. Brustad of Fosston, Minnesota, and certified by the Minnesota Department of Agriculture. This was the northernmost source of certified Smooth Rurals in that state in 1920.

The high-altitude Smooth Rural strain was purchased from J. J. Betler, of Helvetia, in Randolph County, West Virginia, who by rigid hill selection had maintained the strain in a vigorous condition for seven years. Helvetia is approximately 3000 feet above sea level.

The low-altitude Smooth Rural strain was procured from Frank Kelly of Little Falls, in Monongalia County, West Virginia. It was the result of several years of close selection and was regarded as superior by neighboring growers. The Kelly farm is 1200 feet above sea level.

The cooperation of the Kentucky and the Minnesota Stations was obtained in the early winter of 1922. Their participation in the project was of particular value since they are located at the extreme latitudes of the late or main-crop producing sections of the country and were believed to have representative climates for these latitudes.

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In West Virginia the trials were run at the Horticulture Farm of the Agricultural Experiment Station in Morgantown and at three different altitudes in the late or main-crop areas of the state, where seedstock would most likely be grown were it found practicable.

As first planned, the collaborating stations were to exchange seedlots* with the West Virginia Station each season and at the same time to continue those lots already received. This procedure was to continue for four seasons, thus affording comparative trials of seedlots which had originated at one station, grown from one to four years away, and then returned to the originating station for final trial. This arrangement was impossible to follow; for that reason the data from the different experiments will be considered separately by years.

With few exceptions the same planting scheme was used in all trials. This will be described in detail in the consideration of the several trials. The three strains of each seedlot occurred in the plantings in this sequence: (1) the low-altitude strain, (2) the northern-grown strain, and (3) the high-altitude strain. In most of the trials this arrangement was replicated four or more times in order to permit statistical analysis by Student's Method *(3)*, *(4)*, in which the probability of the difference occurring between the paired members of the trial are expressed in odds. Odds of 31 or more to 1 are considered significant.

THE 1921 TRIAL

In 1921 a planting of the three strains was made at Morgantown at an altitude of about 1050 feet, to obtain sufficient seedstock to carry on subsequent tests. The area selected for the planting was moderately level. Four rows, 600 feet long, of each of the strains were planted in the following sequence: (1) the northern-grown strain, (2) the high-altitude strain, and (3) the low-altitude strain. The area was uniformly fertilized, planted, and cultivated. No consistent differences between the strains could be observed during the growing season. The crop was dug by machine and the potatoes were "picked" in consecutive 10-foot lengths of row. The total yields were weighed to quarter-pound accuracy. This procedure permits of the combination of 10-foot increments into plots of different sizes and shapes, and allows for many more plot distributions in the analysis of the data.

Table 1 shows the yield differences in bushels per acre between the strains for two plot distributions, together with the significance of these differences. The yields of corresponding consecutive 50-foot lengths of the two center rows planted with each strain were combined. The first, third, fifth, seventh, and ninth plots of each strain composed the first distribution or grouping. The second, fourth, sixth, eighth, and tenth plots formed the second grouping.

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*A seedlot as here used is a sufficient quantity of each of the three seed strains, used together in equal amounts, to plant the necessary area for a single trial or test. The members of a seedlot have been grown under similar conditions.

TABLE 1.—*Comparison of total yield of seed strains grown on an increase planting in* 1921 *at the Horticulture Farm, Morgantown, W. Va. Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
FIRST GROUPING				
Northern-grown vs. high-altitude	5	191.4—271.8	80.4	632:1
Northern-grown vs. low-altitude	5	191.4—191.1	0.3	None
High-altitude vs. low-altitude	5	271.8—191.1	80.7	574:1
SECOND GROUPING				
Northern-grown vs. high-altitude	5	176.3—269.8	93.5	537:1
Northern-grown vs. low-altitude	5	176.3—214.2	37.6	295:1
High-altitude vs. low-altitude	5	269.8—214.2	55.6	62:1

In both groupings the high-altitude strain outyielded the northern-grown and low-altitude strains significantly; however, there was some question as to the superiority of the low-altitude over the northern-grown stock, since in the first grouping there is apparently no measurable difference in yield, while in the second, the difference is significantly in favor of the low-altitude strain. In this trial the high-altitude strain was superior, with some question as to which of the others rated second.

It is possible that these distributions may be regarded as not systematic and as giving an untrue sampling of the area because the plots planted from a single strain occurred at regular intervals from front to rear and not across the area from right to left. These data are considered of value nevertheless, since the area was some 15 times as long as it was wide and the probability of soil heterogeneity was obviously much greater in this direction than in the short way of the planting.

THE 1922 TRIALS

The stocks grown in 1921 on the Station farm at Morgantown were held in controlled storage until early spring, when seedlots were sent to the Kentucky and Minnesota Stations for trial. Plantings were also made at several altitudes in West Virginia in addition to the one made at Morgantown. The description of the several trials, together with a discussion of the data obtained, follow:

TRIAL NO. 2. KENTUCKY AGRICULTURAL EXPERIMENT STATION, LEXINGTON, KY. ALTITUDE 989 FEET

This planting, made July 10, was probably too early, since this particular season proved to be exceptionally dry and hot. This in part may be responsible for the poor germination that occurred. Three replications were planted in a soil of only moderate fertility. The hill system of planting was used, the rows consisting of 45 hills each. Little spindling sprout was found although all the stock showed leaf roll. At harvest time both total yields and U. S. No. 1 grade were recorded in pounds. (See Table 2.)

TABLE 2.—*Comparison of actual and corrected yields of No. 1's and total yields from seedlot grown at Morgantown in* 1921 *and at the Kentucky Station in* 1922. *Altitude* 989 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
ACTUAL YIELDS OF No. 1's				
Northern-grown vs. high-altitude	4	58.3—46.9	11.4	10:1
Northern-grown vs. low-altitude	4	58.3—46.4	11.9	9:1
High-altitude vs. low-altitude	4	46.9—46.4	0.5	None
ACTUAL TOTAL YIELDS				
Northern-grown vs. high-altitude	4	82.5—77.1	5.4	19:1
Northern-grown vs. low-altitude	4	82.5—60.6	21.9	2:1
High-altitude vs. low-altitude	4	77.1—60.6	16.5	8:1
CORRECTED YIELDS OF No. 1's				
Northern-grown vs. high-altitude	4	140.5—130.4	10.1	2:1
Northern-grown vs. low-altitude	4	140.5—145.7	5.2	5:1
High-altitude vs. low-altitude	4	130.4—145.7	15.3	3:1
CORRECTED TOTAL YIELDS				
Northern-grown vs. high-altitude	4	100.0— 98.7	1.3	None
Northern-grown vs. low-altitude	4	100.0—115.5	15.5	88:1
High-altitude vs. low-altitude	4	98.7—115.5	16.8	4:1

On the basis of actual stand the northern-grown and high-altitude strains outyielded the low-altitude strains. However, on the basis of a perfect stand the low-altitude strains outranked the northern-grown and the high-altitude strains in the order given. This would suggest that the low-altitude sets which grew produced more than those of the other strains, although the only significant differences occurred in total yield between the northern-grown and the low-altitude stocks. Two seedlots from this planting were taken at harvest. One was held in storage at Lexington and the other was sent to West Virginia.

TRIAL NO. 3. HORTICULTURE FARM, MORGANTOWN, W. VA.

Five replications of a planting made up of a 70-foot row from each of the strains were grown. Single guard rows of the same seedstocks were employed as the end rows to eliminate border influences. The planting was harvested September 30th and the total yields per plot row were taken to quarter-pound accuracy.

TABLE 3.—*Comparison of total yields of the seedlot carried over from* 1921 *and grown in* 1922 *at Morgantown, W. Va. Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high altitude	6	228.6—283.1	54.5	85:1
Northern-grown vs. low-altitude	6	228.6—306.3	77.1	132:1
High-altitude vs. low-altitude	6	283.1—306.3	23.2	4:1

Table 3 shows that the low-altitude and the high-altitude stocks were significantly superior in total yield to the northern-grown strain in the order given. The comparison of the native strains gave a considerable difference in favor of the low-altitude strain. However, because of the variation in the yields, little confidence is to be placed in this difference. Both native strains were better in this trial, the low-altitude strain ranking first.

TRIAL NO. 4. FARM OF FRANK KELLY, LITTLE FALLS, W. VA. ALTITUDE 1200 FEET

The planting of this trial was similar to that at the Horticulture Farm with the exception that the row length was 50 feet instead of 70 feet. The seedlot was from the same source and the same sort of data were taken at harvest. (See Table 4.)

TABLE 4.—*Comparison of total yields of seedlot carried over from the* 1921 *planting at Morgantown and grown at Little Falls, W. Va., in* 1922. *Altitude* 1200 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	6	77.0—92.6	15.6	51:1
Northern-grown vs. low-altitude	6	77.0—90.9	13.9	50:1
High-altitude vs. low-altitude	6	92.6—90.9	1.7	2:1

Significant differences in yield occurred in favor of both the high-altitude and the low-altitude strains over that from the North. The high-altitude strain showed a slight increase over the low-altitude stock, but the difference was of no significance.

TRIAL NO. 5. FARM OF R. F. PAYNE, PHILIPPI, W. VA. ALTITUDE 1550 FEET

The planting, identical in plan with that used on the Kelly Farm, was planted with the same seedstock. The same procedure was employed at harvest. No marked differences in growth could be determined from observation during the season.

TABLE 5.—*Comparison of total yields of seedlot carried over from the* 1921 *planting at Morgantown and grown at Philippi, W. Va., in* 1922. *Altitude* 1550 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	6	154.5—170.8	16.3	68:1
Northern-grown vs. low-altitude	6	154.5—187.3	32.8	3999:1
High-altitude vs. low-altitude	6	170.8—187.3	16.5	209:1

Table 5 shows that the low-altitude strain was markedly superior to both the high-altitude and the northern-grown stocks. The high-altitude was also significantly better than the northern-grown seed.

TRIAL NO. 6. FARM OF W. C. WOLFE, CLIFTON MILLS, W. VA. ALTITUDE 1950 FEET

The same planting plan was used here as on the Kelly and Payne farms, and similar data were taken at harvest. It was thought that during the growing season the high-altitude stock was perhaps a little deeper green in color than the other strains. However, little importance is attributed to this observation.

TABLE 6.—*Comparison of total yields of seedlot carried over from the* 1921 *planting at Morgantown and grown at Clifton Mills, W. Va., in* 1922. *Altitude* 1950 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	6	261.7—273.3	43.6	9:1
Northern-grown vs. low-altitude	6	261.7—229.7	32.0	31:1
High-altitude vs. low-altitude	6	273.3—229.7	11.6	124:1

Table 6 shows that the high-altitude strain slightly outyielded the northern-grown stock. Both the high altitude and the northern-grown stocks significantly out-yielded the low-altitude strain in the order given.

TRIAL NO. 7. MINNESOTA AGRICULTURAL EXPERIMENT STATION, UNIVERSITY FARM, ST. PAUL, MINN. ALTITUDE 940 FEET

Due to lack of space only a single 66-foot row of each strain of the seedlot sent from West Virginia was planted. These three rows were planted in an area devoted to trials of sample lots of certified Minnesota seed. Three systematically distributed plots of each sample lot were planted. The probable error of the certified sample which flanked these strains was assumed to be closely approximate to that which would have occurred had the seedlot strains been given a similar distribution. These yields were as follows:

Northern-grown	...........185.4 ± 19.0	bushels per acre
High-altitude	...............150.4 ± 15.5	bushels per acre
Low-altitude	..................219.0 ± 22.0	bushels per acre

Continuing the assumption that these probable errors are closely approximate and that these yields give a fairly accurate mean of the yields of several plots systematically distributed, the differences between these assumed means were found to be insignificant.

THE 1923 TRIALS

Much the same procedure was continued in 1923 as in 1922: i. e., trials planted from seedlots produced at the Station farm in 1922 were made at Morgantown and at several altitudes in the state.

TRIAL NO. 8. EXPERIMENT STATION, LEXINGTON, KY.

The seedlot used in this planting was grown at Morgantown in 1922 from the initial stocks carried at this Station. It was held in cold storage over winter and sent to Kentucky, where it was planted on July 15th. Four replications of a planting made up of a single row of 27 hills from each seed strain were grown. Prof. A. J. Olney, our collaborator, reported that both the stand and the yield per hill were disappointing, particularly in the case of the high-altitude strain. He was unable to account for the low germination. When the plots were harvested on October 26th, total yields and the yields of No. 1 grade were recorded. Table 7 gives the results of this trial.

TABLE 7.—*Comparison of yields of seedlot from the* 1922 *planting at Morgantown grown at Kentucky in* 1923. *Altitude* 989 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
YIELD OF No. 1's				
Northern-grown vs. high-altitude	5	26.1—19.2	6.9	3:1
Northern-grown vs. low-altitude	5	26.1—30.8	4.7	3:1
High-altitude vs. low-altitude	5	19.2—30.8	11.6	18:1
TOTAL YIELDS				
Northern-grown vs. high-altitude	5	46.1—39.2	6.4	2:1
Northern-grown vs. low-altitude	5	46.1—63.2	17.1	13:1
High-altitude vs. low-altitude	5	39.2—63.2	23.5	8:1

None of the yield differences in this trial is significant, although there is a slight indication that the low-altitude strain gave better yields of both No. 1's and total yields than the high-altitude and northern-grown strains. The northern-grown and the high-altitude strains produced a greater quantity of tubers which were out of grade, as shown in the comparison of the total yields with the No. 1 yield differences. The results check closely with the corrected yields of the planting made at the same station in 1922.

TRIAL NO. 9. HORTICULTURE FARM, MORGANTOWN, W. VA.

Thirty-five replications of a planting made up of a single 30-foot row of each of the three strains were planted on April 16th from the original stocks maintained at the Station farm. The total yields were recorded in pounds. In the analysis of these data several systematic groupings of the different plot series were made. The first group used in these comparisons consisted of the initial planting and every sixth series thereafter. The second grouping comprised the first replication of the basal planting and every sixth series thereafter. This system of grouping was continued until all the series were included. Table 8 gives the significance of the yield differences for these groupings.

There were no significant differences between the yields of the different stocks in any of the groupings. However, there was a tendency for the high-altitude strain to be superior to both the northern-grown and the low-altitude strains. No appreciable difference in yields existed between the northern and low-altitude strains. This method of analysis is supported by the comparison of the means of the total yields of the entire planting of 36 series. Table 9 gives the differences in mean yields obtained by Bessel's formula, together with the significance of these differences.

The results by both methods of analysis agree very closely.

TABLE 8.—*Comparisons of total yields from six systematic distributions composed of six series each of the* 1923 *trial at Morgantown planted with seedstock maintained at the Horticulture Farm. Altitude* 1050 *feet*

Distribution composed of series number	Comparison	Average yield in bu. per acre	Yield differences in bu. per acre	Odds
1, 7, 13, 19, 25, 31	N-grown vs. hi-alt	59.0—69.7	10.7	18:1
	N-grown vs. lo-alt	59.0—67.8	8.8	9:1
	Hi-alt vs. lo-alt	69.7—67.8	1.9	2:1
2, 8, 14, 20, 26, 32	N-grown vs. hi-alt	50.3—51.8	1.5	2:1
	N-grown vs. lo-alt	50.3—53.2	2.9	2:1
	Hi-alt vs. lo-alt	51.8—53.2	1.4	1:1
3, 9, 15, 21, 27, 33	N-grown vs. hi-alt	53.7—59.0	5.3	9:1
	N-grown vs. lo-alt	53.7—45.5	8.2	4:1
	Hi-alt vs. lo-alt	59.0—45.5	13.5	10:1
4, 10, 16, 22, 28, 34	N-grown vs. hi-alt	57.6—61.0	3.4	3:1
	N-grown vs. lo-alt	57.6—56.6	1.0	2:1
	Hi-alt vs. lo-alt	61.0—56.6	4.4	3:1
5, 11, 17, 23, 29, 35	N-grown vs. hi-alt	50.3—50.3	None	None
	N-grown vs. lo-alt	50.3—49.9	0.4	1:1
	Hi-alt vs. lo-alt	50.3—49.9	0.4	1:1
6, 12, 18, 24 30, 36	N-grown vs. hi-alt	65.8—74.1	8.3	4:1
	N-grown vs. lo-alt	65.8—65.8	None	None
	Hi-alt vs. lo-alt	74.1—65.8	8.3	4:1

TABLE 9.—*Comparison of mean total yields for each strain from the trial planted on the Horticulture Farm at Morgantown in* 1923. *Altitude* 1050 *feet*

Comparison	Number of series	Mean yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	36	58.6±2.2—62.4±2.5	3.8±3.3	1.4:1
Northern-grown vs. low-altitude	36	58.6±2.2—58.6±2.1	None	None
High-altitude vs. low-altitude	36	62.4±2.5—58.6±2.1	3.8±3.2	1.4:1

TRIAL NO. 10. HORTICULTURE FARM, MORGANTOWN, W. VA.

This trial was planted with a seedlot returned from Lexington, Kentucky, which had been grown at Morgantown in 1921 and in Lexington in 1922. The trial included nine replications of a planting composed of a 30-foot row of each of the three strains. Table 10 summarizes the results of this trial.

TABLE 10.—*Comparison of total yields of the* 1923 *trial at Morgantown planted with the seedlot grown in West Virginia in* 1921 *and in Kentucky in* 1922. *Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	10	64.9—75.5	10.6	113:1
Nortern-grown vs. low-altitude	10	64.9—84.2	19.3	Abs. signif.
High-altitude vs. low-altitude	10	75.5—84.2	8.7	15:1

Both the high and the low-altitude strains outyielded the northern-grown strains. The low-altitude strain was apparently superior to the high although the difference between them was not significant.

TRIAL NO. 11. HORTICULTURE FARM, MORGANTOWN, W. VA.

This trial was planted with a seedlot received from the Minnesota Station which had been grown in West Virginia in 1921 and at Minnesota in 1922. The planting included five series, each composed of a 30-foot row of each of the strains. The results of this trial are summarized in Table 11.

TABLE 11.—*Comparison of yields of the* 1923 *trial at Morgantown planted with the seedlot grown in West Virginia in* 1921 *and in Minnesota in* 1922. *Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	5	73.1—68.7	4.4	4:1
Nortern-grown vs. low-altitude	5	73.1—65.8	7.3	5:1
High-altitude vs. low-altitude	5	68.7—65.8	2.9	3:1

There were no significant differences between the yields of these strains. However, there is a slight indication in favor of the northern-grown and the high-altitude in the order given.

TRIAL NO. 12. FARM OF R. F. PAYNE, PHILIPPI, W. VA.

Eight replications of a planting consisting of a single 30-foot row from each of the seed strains were planted. This seedlot had been maintained at Morgantown since 1921. Table 12 gives the differences between the total yields.

TABLE 12.—*Comparison of total yields of seedlot carried at Morgantown in* 1921 *and* 1922 *and grown at Philippi, W. Va., in* 1923. *Altitude* 1550 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	9	218.8—234.3	15.5	28:1
Northern-grown vs. low-altitude	9	218.8—258.9	40.1	155:1
High-altitude vs. low-altitude	9	234.3—258.9	24.6	15:1

Both West Virginia strains outyielded the northern stock in this trial, the low-altitude being significantly better. The differences between the high-altitude and the northern-grown, and between the low-altitude and the high altitude, are wide but not significant.

TRIAL NO. 13. FARM OF W. C. WOLFE, CLIFTON MILLS, W. VA.

Five replications of a planting made up of a single 30-foot row of each strain were planted. The seedlot came from the stocks maintained on the Horticulture Farm at Morgantown. Table 13 summarizes the results of this trial.

TABLE 13.—*Comparison of total yields of seedlot carried at Morgantown in* 1921 *and* 1922 *and grown at Clifton Mills, W. Va., in* 1923. *Altitude* 1950 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	6	243.4—290.9	47.5	735:1
Northern-grown vs. low-altitude	6	243.4—267.7	24.3	72:1
High-altitude vs. low-altitude	6	290.9—267.7	23.2	14:1

Both strains of West Virginia seedstock were distinctly superior in this trial—the high-altitude strain ranking first. However, the yield differences between these strains were not significant.

TRIAL NO. 14. NORTHEAST MINNESOTA SUBSTATION, DULUTH, MINN. ALTITUDE 1133 FEET.

The seedlot used in the planting of this trial had been grown at the West Virginia Station for two years and shipped to the Minnesota Substation in the spring of 1923. Three replications of a planting consisting of a single 50-foot row of each strain were planted. Table 14 shows yield comparisons made between these stocks.

TABLE 14.—*Comparison of total yields of trial at Duluth, Minnesota, in* 1923, *planted with seedlot carried at Morgantown in* 1921 *and* 1922. *Altitude* 1133 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
Northern-grown vs. high-altitude	4	429.8—233.8	196.0	25:1
Northern-grown vs. low-altitude	4	429.8— 94.9	334.9	171:1
High-altitude vs. low-altitude	4	233.8— 94.9	138.9	101:1

The northern-grown and high-altitude strains outyielded the low-altitude strain significantly. Even though there is an indication of the superiority of the northern-grown over the high-altitude strain the difference in their total yields is not significant.

THE 1924 TRIALS

In 1924 trials were made only at Morgantown from seedlots taken from the 1923 plantings at the collaborating stations and from the stocks which had been continued at the Horticulture Farm since 1921.

TRIAL NO. 15. HORTICULTURE FARM, MORGANTOWN, W. VA.

The trial consisted of 13 series of a planting composed of a 30-foot row of each of the strains. This seed stock had been maintained at Morgantown since 1921. Table 15 summarizes the results of this trial.

TABLE 15.—*Comparison of yields of the planting at the Horticulture Farm in* 1924 *from the original seedstocks carried at Morgantown since* 1921. *Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
YIELD OF No. 1's				
Northern-grown vs. high-altitude	13	80.1—98.3	18.2	198:1
Northern-grown vs. low-altitude	13	80.1—91.0	10.9	5:1
High-altitude vs. low-altitude	13	98.3—91.0	7.3	3:1
TOTAL YIELDS				
Northern-grown vs. high-altitude	13	137.0—122.9	14.1	133:1
Northern-grown vs. low-altitude	13	137.0—152.5	15.5	10:1
High-altitude vs. low-altitude	13	122.9—152.5	29.6	11:1

The high-altitude strain significantly outyielded the northern-grown strain both in yield of No. 1's and in total yields. The low-altitude yielded slightly more also, but not enough to be considered as conclusively better. There was no significance in yield between the native strains, although the high-altitude gave a slightly higher yield.

TRIAL NO. 16. HORTICULTURE FARM, MORGANTOWN, W. VA.

The seedstock used in this trial was grown in 1921 and 1922 at Morgantown, in 1923 at Duluth, Minnesota, and returned to Morgantown in 1924. The planting was made up of four replications of a series composed of a single 30-foot row of each of the strains.

TABLE 16.—*Comparison of yields of seedstocks carried at Morgantown in* 1921 *and* 1922, *at Duluth, Minn., in* 1923, *and grown at Morgantown in* 1924. *Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
YIELD OF No. 1's				
Northern-grown vs. high-altitude	5	159.2—165.5	6.3	None
Northern-grown vs. low-altitude	5	159.2—134.6	24.6	4:1
High-altitude vs. low-altitude	5	165.5—134.6	30.9	32:1
TOTAL YIELDS				
Northern-grown vs. high-altitude	5	254.1—244.4	9.7	2:1
Northern-grown vs. low-altitude	5	254.1—218.8	35.3	7:1
High-altitude vs. low-altitude	5	244.4—218.8	25.6	7:1

Table 16, in which the results of Trial 16 are given, shows the only significant difference in yield of No. 1's between the West Virginia strains to occur in favor of the high-altitude strain. Apparently the low-altitude strain was poorest. There was no appreciable difference in the yield of No. 1's and the total yields between the northern-grown and the high-altitude strains.

TRIAL NO. 17. HORTICULTURE FARM, MORGANTOWN, W. VA.

The description of the seedstock used in this trial as well as the planting plan employed are similar to that of Trial 16, except that the seedlot had been one year in Kentucky and that five replications of the basal planting were employed instead of four. Table 17 summarizes the results of this trial.

TABLE 17.—*Comparison of yields of seedlot carried at Morgantown during* 1921 *and* 1922, *at Lexington, Ky., in* 1923, *and grown at Morgantown in* 1924. *Altitude* 1050 *feet*

Comparison	Number of series	Average yields in bu. per acre	Yield differences in bu. per acre	Odds
YIELD OF No. 1's				
Northern-grown vs. high-altitude	6	105.0—124.9	19.9	10:1
Northern-grown vs. low-altitude	6	105.0—109.4	4.4	2:1
High-altitude vs. low-altitude	6	124.9—109.4	15.5	10:1
TOTAL YIELDS				
Northern-grown vs. high-altitude	6	184.4—203.8	19.4	6:1
Northern-grown vs. low-altitude	6	184.4—171.8	12.6	2:1
High-altitude vs. low-altitude	6	203.8—171.8	32.0	14:1

No significant differences between yields occurred, although the high-altitude and northern-grown strains produced more in the order named.

At attempt has been made in Table 18 to summarize the results obtained during the course of these trials. The one carried on at University Farm, St. Paul, Minnesota, in 1922, has been included in the table because of the consistency of the results with those of the other trials in which the seedlots have been given the same treatment. However, the results of this trial are considered of little value because of the limited data available. They are not included in the discussion.

Table 18 shows the high-altitude strain to have outyielded the northern-grown strain in 11 of the 16 trials. The differences in its favor were significant in six of these trials. In two of the five trials remaining in which the northern-grown stock yielded most, the differences were significant. The rating of these strains in the trials run in West Virginia shows the high-altitude strain to have placed first in seven trials and second in five, while the northern-grown placed first in two and second in four trials. When all the trials are included, the high-altitude strain placed first in seven and second in seven, while the northern-grown placed first in four and second in five trials.

TABLE 18.—*Summary of results of seventeen trials (1921 to 1924, inclusive) planted with identical strains at four altitudes in West Virginia and at the Kentucky and Minnesota Stations*

Trial number	Year	Location of planting	Altitude	Comparison†			Rank of Strains			Source of seedstock	Treatment
				N-grown vs. hi-alt	N-grown vs. lo-alt	Hi-alt vs. lo-alt	N-grown	Hi-alt	Lo-alt	Original sources	Increase
1	1921	Morgantown, W. Va.	1050	**Hi-alt**	Lo-alt	**Hi-alt**	3	1	2		
2	1922	Lexington, Ky.*	989	N-grown	N-grown	Hi-alt	1	2	3	Trial 1	At Morgantown 1 year
3	1922	Morgantown, W. Va.	1050	**Hi-alt**	**Lo-alt**	Lo-alt	2	3	1	Trial 1	At Morgantown 1 year
4	1922	Little Falls, W. Va.	1200	Hi-alt	**Lo-alt**	Hi-alt	3	1	2	Trial 1	At Morgantown 1 year
5	1922	Philippi, W. Va.	1550	**Hi-alt**	**Lo-alt**	**Lo-alt**	3	2	1	Trial 1	At Morgantown 1 year
6	1922	Clifton Mills, W. Va.	1950	Hi-alt	**N-grown**	**Hi-alt**	2	1	3	Trial 1	At Morgantown 1 year
7‡	1922	University Farm, Minn.**	940	N-grown	Lo-alt	Lo-alt	2	3	1	Trial 1	At Morgantown 1 year
8	1923	Lexington, Ky.*	989	N-grown	Lo-alt	Lo-alt	2	3	1	Trial 3	At Morgantown 2 years
9	1923	Morgantown, W. Va.	1050	Hi-alt	N-grown	Hi-alt	2	1	3	Trial 3	At Morgantown 2 years
10	1923	Morgantown, W. Va.	1050	**Hi-alt**	**Lo-alt**	Lo-alt	3	2	1	Trial 2	At Morgantown 1 year, Kentucky 1 year
11	1923	Morgantown, W. Va.	1050	**N-grown**	**N-grown**	Hi-alt	1	2	3	Trial 7	At Morgantown 1 year, Minnesota 1 year
12	1923	Philippi, W. Va.	1550	Hi-alt	**Lo-alt**	Lo-alt	3	2	1	Trial 3	Two years at Morgantown
13	1923	Clifton Mills, W. Va.	1950	**Hi-alt**	**Lo-alt**	Hi-alt	3	1	2	Trial 3	Two years at Morgantown
14	1923	Duluth, Minn.**	1133	**N-grown**	**N-grown**	Hi-alt	1	2	3	Trial 3	Two years at Morgantown
15	1924	Morgantown, W. Va.	1050	**Hi-alt**	Lo-alt	Hi-alt	3	1	2	Trial 9	Three years at Morgantown
16	1924	Morgantown, W. Va.	1050	N-grown	N-grown	Hi-alt	1	2	3	Trial 14	Two years at Morgantown, 1 year at Minnesota
17	1924	Morgantown, W. Va.	1050	Hi-alt	N-grown	Hi-alt	2	1	3	Trial 8	Two years at Morgantown, 1 year at Kentucky

†Differences are significant in comparisons having bold-faced type.
*Southernmost.
**Northernmost.
‡Attention is directed to page 10.

A comparison of the northern-grown with the low-altitude strain shows the latter to have yielded most in nine of the sixteen trials. The yield differences were significantly better in six of these trials. In three of the seven trials remaining the northern-grown was conclusively superior.

Table 18 shows the high-altitude to have outyielded the low-altitude strain in eleven of the sixteen trials, but in only two are the differences significant. The low-altitude significantly outyielded the high-altitude strain in only one of the five remaining trials. In the comparison of the trials run in West Virginia the low-altitude strain ranked first in four instances and second in four. It ranked first in five and second in four when all the trials are included for consideration.

In only two of the sixteen trials was the northern-grown unquestionably superior to both West Virginia strains. The differences in all other trials favoring it were so slight as to have no significance.

Table 18 does not show conclusively that the place in which the seedlot is grown caused a change in the relationship of the strains in a definite direction. It is, however, of interest in that there seems to be a tendency for the high-altitude and northern-grown strains to yield highest at the highest altitude (1950 feet) in West Virginia and in Minnesota. This tendency is not as marked in respect to the low-altitude strain when grown at the lower altitudes of West Virginia (1050 to 1550 feet) and in Kentucky. It is also of note that the northern-grown strain from seedlots grown in Morgantown which were produced in Minnesota gave largest yields. The same is true with the low-altitude strain when produced the previous year in Kentucky.

DISCUSSION

The opinion is prevalent among growers that it is impracticable to attempt to produce potato seedstocks in this state which are reasonably comparable with those from the established sections of the North. With this in mind these experiments were designed to determine whether a recommended strain of seedstock from a northern seed-producing area would show outstanding characters when maintained for a series of years in plantings with highly selected native strains originated at the extreme altitudes in the state at which seedstocks would likely be grown (1050 to 3000 feet).

Yield only was taken as a criterion of value, since differences between the strains with respect to susceptibility to disease, insect injury, particular response to growing conditions, etc. would naturally be reflected in the yield. For this reason accepted practices of culture were employed. No attempts were made to take disease counts or to rogue or select within the plantings. On the contrary, a particular point was made to expose all the strains equally to the same hazards as occur in the normal production of the commercial crop in the state.

There may also be some question on the part of the reader as to the justification of interpreting some of the results as contributing directly to proof that one strain was superior to another when the differences are shown to be insignificant.

The use of these data is here considered as being justified, in view of the general consistency of the results of these trials, in indicating that the native strains yielded most in West Virginia, even though the differences were not of mathematical significance in several instances. The data taken as a whole strongly indicate that there were differences in yielding capacity between the strains and that these differences persisted from year to year under the ordinary growing conditions of commercial crop production in this state.

SUMMARY

During the years 1921 to 1924, inclusive, 17 trials were carried on at four altitudes in West Virginia—from 1000 to 2000 feet—and at two latitudes outside the state—at the Kentucky and Minnesota Experiment Stations—in order to compare the performance, as measured by yield, of two native strains of Smooth Rural seed potatoes with a recommended strain of the same variety from the North, to determine primarily the feasibility of seed potato production in certain of the upland areas of this state. Observations were also made to ascertain to what degree, as shown by yield comparisons, changes of latitude were paralleled in effect on the strains by increase or decrease in altitude.

The native strains of seed potatoes had been maintained for a number of years at the high and low-altitude limits at which seed potatoes would likely be produced. The northern strain was produced in the extreme northern part of Minnesota.

The native strains (particularly the high-altitude strain) were superior to the northern-grown strain in the initial increase plantings at Morgantown in 1921. The differences in yield favoring these strains apparently persisted, since, with few exceptions, the native strains equaled or bettered the northern strain in yield in those trials carried on in West Virginia. The altitude at which the trials were run usually determined which of the native strains proved superior. Usually the high-altitude and northern-grown stocks gave higher yields at the higher altitudes, even as did the low-altitude strain in trials at the lower altitudes.

From the results of these trials it is apparent that the native strains compared favorably in performance with the northern strain; that these trials strongly indicate that the native strains did not deteriorate more rapidly than the northern strain. It is concluded therefore that it is feasible to produce seed potatoes in the medium altitudes of this state.

There appeared to be a tendency, although the data were meager and somewhat inconsistent, for the northern-grown and the high-altitude seed strains to yield more than the low-altitude strain in trials run in Minnesota and in the higher altitudes of West Virginia. Also, the low-altitude strain was usually superior in trials run at Kentucky and in the lower altitudes of West Virginia. This would suggest that an increase in altitude has an effect on the relative comparison of the strains similar to a change to a more northern latitude.

Since the northern-grown strain yielded more than the others in trials in West Virginia after a year in Minnesota, and the low-altitude strain acted similarly after a year in Kentucky, it would seem that the strains were not uniformly affected by the changed conditions: i. e., even a year's return of a strain to environmental conditions similar to those under which it was native caused an increase in vigor as here expressed by yields.

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